Exposure to Extreme Heat & Precipitation Events and Increased Risk of Hospitalization for Asthma in Maryland

Soneja S., Jiang CJ., Upperman C., Fisher J., Murtugudde R., He X., Sapkota AR., Mitchell C., **Sapkota A.**

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UNIVERSITY OF MARYLAND 18 56
SCHOOL OF PUBLIC HEALTH
MARYLAND INSTITUTE FOR APPLIED ENVIRONMENTAL HEALTH MIAEH

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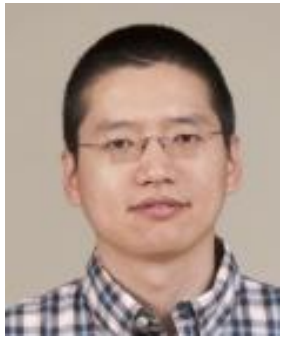
Amir Sapkota, PhD
UMD

Sut Soneja, PhD
UMD



Chengsheng Jiang, PhD
UMD

Cliff S. Mitchell, MD
DHMH

Jared Fisher
UMD

R. Murtugudde, PhD
UMD

Xin He, PhD
UMD

Crystal Upperman
UMD

Outline

- Background
- Results
  - Extreme heat/precipitation events and ER visit for asthma
- El Niño Southern Oscillation (ENSO) and extreme events
  - Phase of ENSO and selected health outcomes in MD
- Conclusion/Discussion

Background: Asthma

- Over 25 million Americans are currently living with asthma (2010).
- It costs US economy over $56 billion/year

- Several studies have investigated associations between ambient temperature & precipitation and increased risk of asthma exacerbations

Background: Weather and Asthma

- Exposures to elevated temperature associated with increased risk of hospitalization for asthma

- Thunderstorm events, or periods of heavy rainfall and intense wind
  - trigger the release of fungal spores that are carried by wind

Looking into the Future…

- Frequency, intensity, and duration of extreme events will continue to rise in response to our changing climate (Field et al. 2012)

- How such events will impact allergic diseases such as asthma remains unknown.

Study Population

Maryland hospitalizations (2000-2012)

- Principal discharge diagnosis of Asthma (ICD-9 493)
- N= 115,923
- Demographic information
  - Age
  - Gender
  - Race/ethnicity
  - County of residence

Exposure Metric

- Extreme heat events
  - Daily temperature exceeding 95th percentile of county and calendar day specific Tmax values for 1960-1989
- Extreme precipitation events
  - Daily precipitation exceeding 90th percentile of county and calendar day specific Precip for 1960-1989

Statistical Analysis

Time-stratified case-crossover study design

Case period: day of hospitalization

Control periods: 3 days (7, 14, 21 days before/after)

Conditional logistic regression

Stratified models:

Age categories: 0-4 years, 5-17 years, 18-64 years, and >=65 years

Ethnicity: Non-Hispanic White, Non-Hispanic Black, and Hispanic

Sensitivity analyses

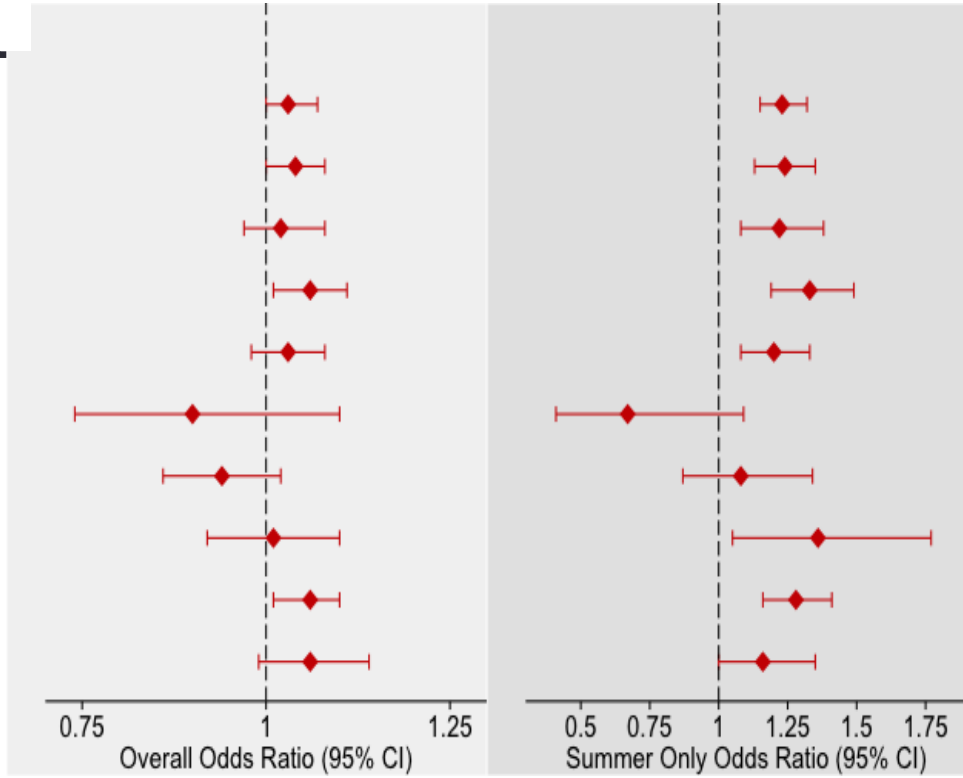
Controlling for $PM_{2.5}$, Different thresholds, and Lagged exposure

Table 1. Case demographics by season for January 1, 2000 to December 14, 2012

Characteristic	Hospitalizations - No. (%) Segmented by Season[a] Winter (n=30,436)	Spring (n=31,103)	Summer (n=20,776)	Autumn (n=33,608)	Total (n=115,923)
Gender[b]					
Female	19,326 (64)	18,954 (61)	13,081 (63)	19,334 (58)	70,695 (61)
Male	11,110 (36)	12,148 (39)	7,695 (37)	14,273 (42)	45,226 (39)
Age at hospitalization, median (IQR), yrs[c]	47 (20-62)	44 (12-60)	47 (27-61)	37 (7-55)	44 (12-60)
Age Group[d]					
≤4	4,397 (15)	4,841 (16)	2,663 (13)	6,142 (18)	18,043 (16)
5 to 17	3,350 (11)	4,669 (15)	1,846 (9)	6,784 (20)	16,649 (14)
18 to 64	16,256 (53)	15,400 (50)	11,993 (58)	15,813 (47)	59,462 (51)
≥65	6,433 (21)	6,192 (20)	4,274 (21)	4,869 (15)	21,768 (19)
Race/Ethnicity					
Non-Hispanic White	13,320 (44)	12,930 (42)	8,132 (39)	12,769 (38)	47,151 (41)
Non-Hispanic Black	14,513 (48)	15,296 (49)	10,913 (53)	17,625 (52)	58,347 (50)
Hispanic	754 (3)	879 (3)	446 (2)	968 (3)	3,047 (3)
Other	860 (3)	957 (3)	545 (3)	1,117 (3)	3,479 (3)
Unknown	989 (3)	1,041 (3)	740 (4)	1,129 (3)	3,899 (3)

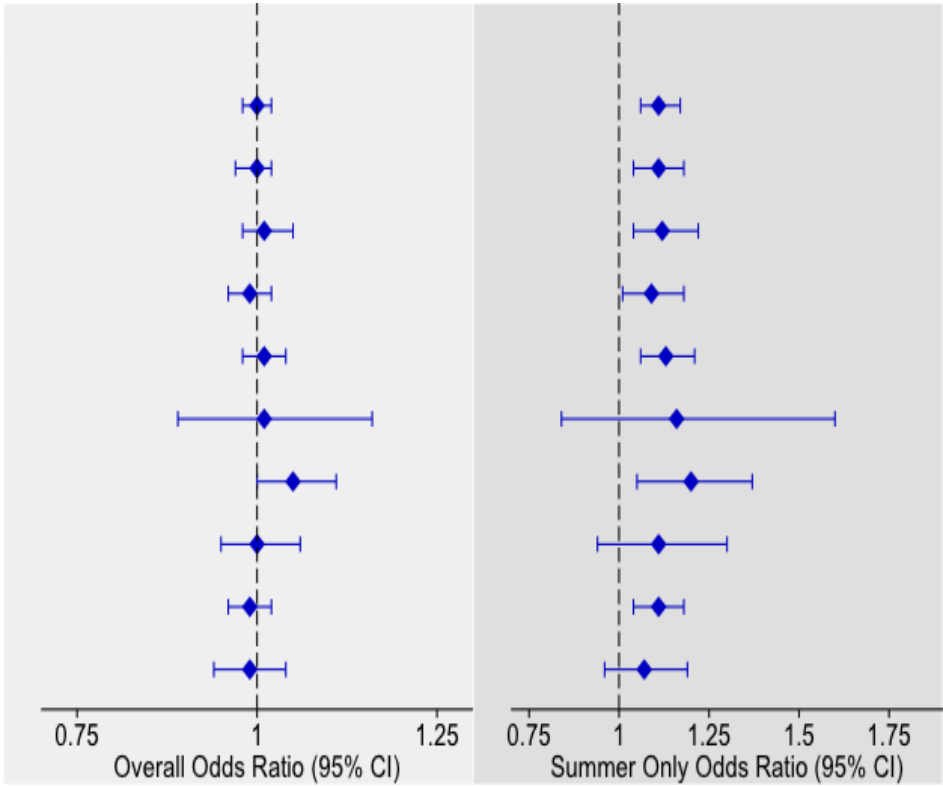
Extreme Heat Events and Risk of ER Visit for Asthma

Characteristics	Subgroups	Overall OR (95%CI	Summer Only OR (95%CI)
All	All of Maryland	1.03 (1.00, 1.07)	1.23 (1.15, 1.32)
Gender	Female	1.04 (1.00, 1.08)	1.24 (1.13, 1.35)
	Male	1.02 (0.97, 1.08)	1.22 (1.08, 1.38)
Race/Ethnicity	White	1.06 (1.01, 1.11)	1.33 (1.19, 1.49)
	Black	1.03 (0.98, 1.08)	1.20 (1.08, 1.33)
	Hispanic	0.90 (0.74, 1.10)	0.67 (0.41, 1.09)
Age Group	0 to 4	0.94 (0.86, 1.02)	1.08 (0.87, 1.34)
	5 to 17	1.01 (0.92, 1.10)	1.36 (1.05, 1.77)
	18 to 64	1.06 (1.01, 1.10)	1.28 (1.16, 1.41)
	65 and over	1.06 (0.99, 1.14)	1.16 (1.00, 1.35)



Extreme Precipitation Events and Risk of ER Visit for Asthma

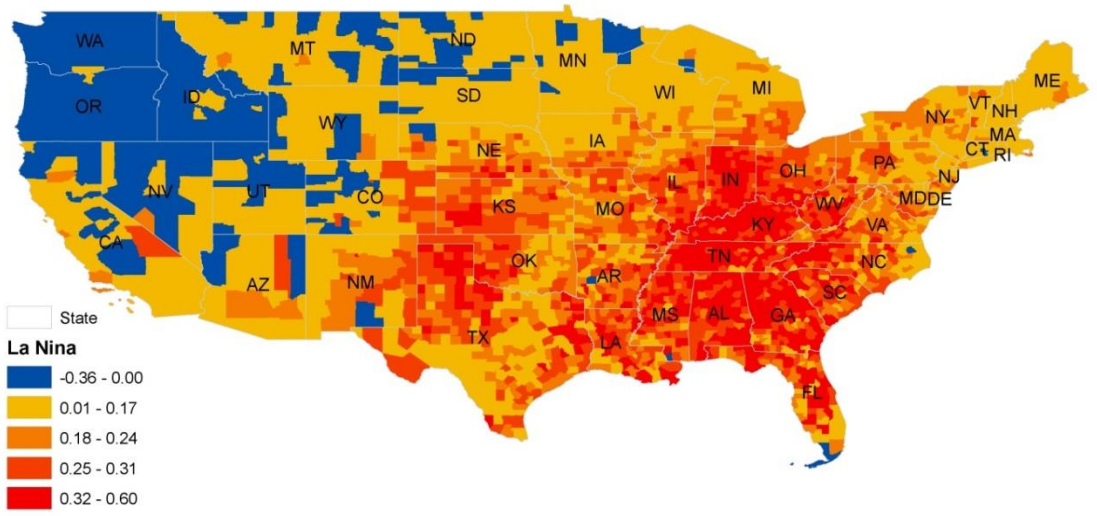
Characteristics	Subgroups	Overall OR (95%CI)	Summer Only OR (95%CI)
All	All of Maryland	1.00 (0.98, 1.02)	1.11 (1.06, 1.17)
Gender	Female	1.00 (0.97, 1.02)	1.11 (1.04, 1.18)
	Male	1.01 (0.98, 1.05)	1.12 (1.04, 1.22)
Race/Ethnicity	White	0.99 (0.96, 1.02)	1.09 (1.01, 1.18)
	Black	1.01 (0.98, 1.04)	1.13 (1.06, 1.21)
	Hispanic	1.01 (0.89, 1.16)	1.16 (0.84, 1.60)
Age Group	0 to 4	1.05 (1.00, 1.11)	1.20 (1.05, 1.37)
	5 to 17	1.00 (0.95, 1.06)	1.11 (0.94, 1.30)
	18 to 64	0.99 (0.96, 1.02)	1.11 (1.04, 1.18)
	65 and over	0.99 (0.94, 1.04)	1.07 (0.96, 1.19)

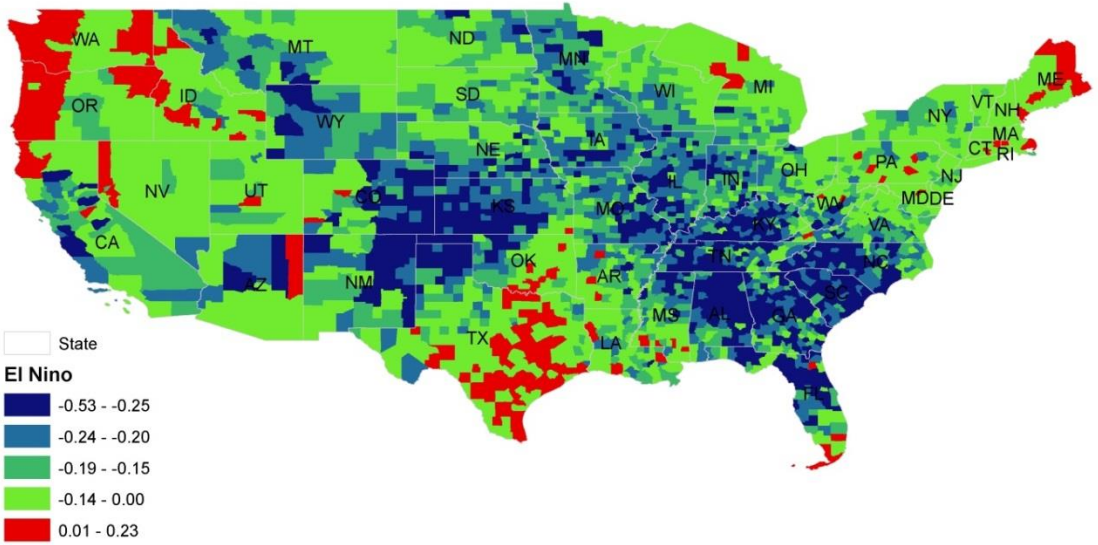


How Does Extreme Event Related Impaired Health Differ by Phases of ENSO?

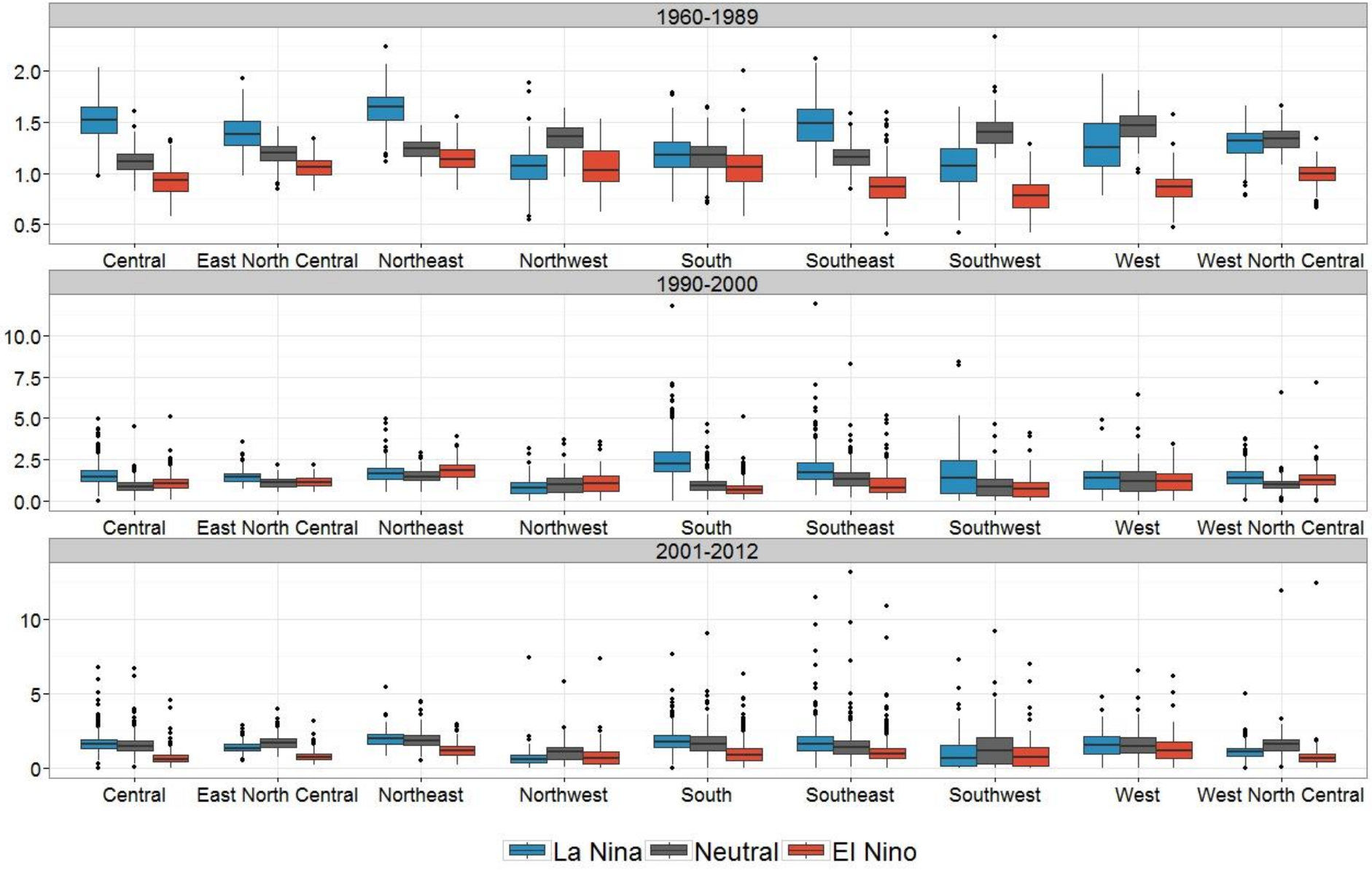
- El Niño Southern Oscillation (ENSO) is a naturally occurring Ocean-Atmosphere “coupled” phenomenon.
- Deviation in sea surface temperature at Nino 3.4 region, compared to 30 year baseline.
- Irregular cycle with alternating cold/warm periods
  - Positive deviation (Warm phase): El Niño
  - Negative deviation (Cold phase): La Niña
  - No deviation: ENSO Neutral
- Influences weather patterns across the world including CONUS

Relative Change in Extreme Heat Event During La Nina and El Nino 1960-2010

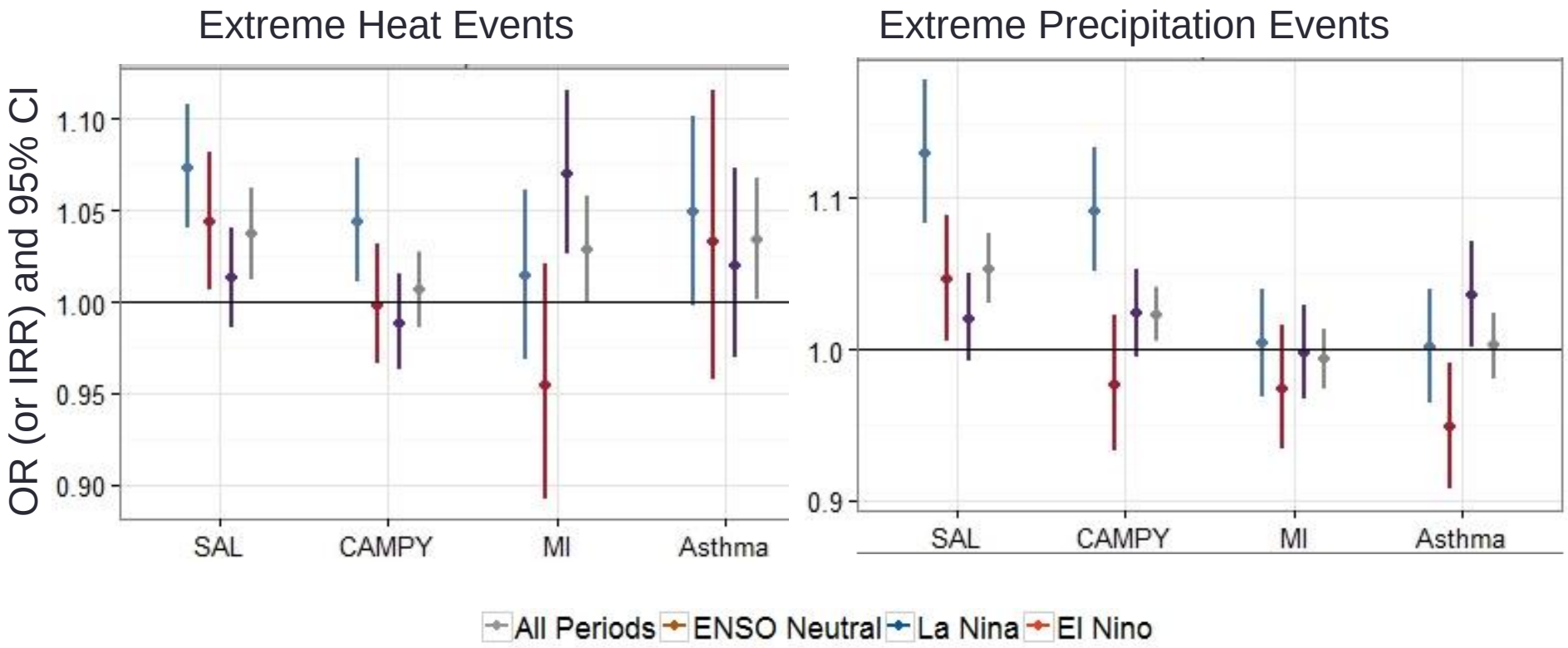




Extreme Heat Event by Phases of ENSO



Stratified by phases of ENSO



Summary

- Exposures to increased frequency of extreme heat and precipitation events, particularly during summer months, are associated with increased risk of asthma ED visits in Maryland.

- IPCC estimates the frequency of extreme events to increase in the foreseeable future in response to changing climate. Our findings serves to contextualize this in terms of disease risk.

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Moving Forward

- Intensity as well as duration of extreme events and Impaired Health
- Adaptive measures and changes in risk
- Spatial variability in risk associated with large scale phenomenon such as ENSO events, that are known driver of climate variability.